TABLE OF CONTENTS

INTRODUCTION 1

KNOWN FISHERIES STUDIES OF THE WHITE RIVER, UTAH . . . 2

Known Fish Sample Sites 4

Fish Species Composition and Distribution 5

Threatened and Endangered Fishes. 13

DISCUSSION 14

Fishes as a Monitoring Tool 15

Monitoring Fishes of the White River. 18

Current Studies and Data Gaps 22

LITERATURE CITED. 24

APPENDIX 27

INTRODUCTION

This survey of fish collections in the White River, Utah was assimilated to provide White River Shale Oil Corporation (WRSOC) with a perspective of the riverine fisheries resources adjacent to Tracts Ua and Ub. All known fisheries studies of the White River within the state of Utah are cited and the appropriate data from each compared to provide a synopsis of past and current efforts. Information gleaned from each report is presented in tabular form, including the location and description of each known sample site, investigators involved, sample dates, and gear types used. An arbitrary sample code is assigned to each significant collection that corresponds to a sample site identified on river maps included in this report. Also included in tabular form are locations and descriptions of known capture sites of threatened and endangered fishes. Each fish is assigned an arbitrary number indicated on river maps in this report and corresponding to species name, investigators involved, date and location captured, total length and weight, and tag or identification number. A literature cited section is provided as a compendium of fisheries works in the White River, Utah. The maps in this report are reduced photocopies of standard USGS 15-minute series topographic quadrangle maps. River miles, measured upstream from the White River-Green River confluence, are indicated on the maps at intervals of 5 miles. Some discrepancies were found between reports cited as to river-mile locations. Most, however, were reasonably

consistent, but sample site and fish capture locations should be considered close approximations; generally within one mile of the actual site.

This report also provides a brief description of current fisheries investigations in the White River within the state of Utah. This section is intended to update WRSOC on current studies near Tracts Ua and Ub.

The final section of this survey is a discussion of the feasibility of using fishes as an ecosystem environmental monitoring tool. This assessment considers the completeness and appropriateness of the known fisheries data discussed earlier and anticipated data collections of current studies. Data gaps are identified and the need for a fishes monitoring program is explored. The second part of this discussion section considers the need and feasibility of a monitoring program for threatened and endangered fishes in the White River. These needs are discussed in light of the requirements of Section 7 of the Endangered Species Act for permitting of oil shale operations.

KNOWN FISHERIES STUDIES OF THE WHITE RIVER, UTAH

Well-documented fisheries investigations of the White River are lacking prior to 1974. Studies since then have documented species incidence and composition with the major emphasis on threatened and endangered fishes. A number of early investigations were conducted in the Green River in and around the mouth of the White River (Vanicek 1967, Vanicek et al. 1970, Holden and Stalnaker 1975, McAda 1977, Seethaler 1978) but few sampled

upstream of the confluence.

Although Holden and Stalnaker (1975) mention the White River as part of their 1967-1973 study of the Upper Colorado River Basin, no records of fish collections are presented. In 1974-1975, Crosby (1975a,b) conducted a series of fish collections in the White River within the state of Utah. This appears to be the first quantitative investigation of this resource. Prewitt et al. (1978) did a 1977 baseline survey of the aquatic macroinvertebrates and fishes of the upper White River in Colorado. The most intensive and well-documented study of the White River in Utah was conducted by Lanigan and Berry (1979) in 1978 and 1979. A review of this study is in open literature (Lanigan and Berry 1981). This study reported the first documented capture of the endangered Colorado squawfish in the Utah portion of the White River. Shortly after this study, the Fish and Wildlife Service (FWS) incorporated the White River into their extensive investigation of the Upper Colorado River Basin, the Colorado River Fishery Project (CRFP). A preliminary survey of the White River was done in late 1980, but intensive sampling did not begin until April 1981 (Miller et al. 1982). This CRFP investigation confirmed the presence of threatened and endangered fishes in the White River through a program of radiotelemetry with Colorado squawfish. In a cooperative effort with the FWS, Ecosystem Research Institute (1982) in 1981 conducted joint seining and drift net sampling of the White River in Colorado and Utah to assess the ecological requirements and food habits of the riverine fishes. Also, as a cooperative effort with the ongoing FWS program, Radant et al. (1983) conducted

Colorado squawfish investigations in the White River, Utah as part of an interagency agreement. This program also involved radiotelemetry with Colorado squawfish as a means of assessing the importance of the White River to threatened and endangered fishes. There was a reduced effort of fisheries investigations in the White River in 1983, primarily because of reduced funding and manpower by the FWS. Formal reports of the 1983 sample efforts are not yet available to incorporate into this data survey.

Known Fish Sample Sites

At least 60 fish sample sites can be identified on the White River within the state of Utah, RM 0.0 to RM 71.8 (RM = river mile). These represent the efforts of six investigative groups from 1974 to 1982.

The investigator(s), sample dates, sites and sample types are identified in Table A-1. Each sample effort is assigned an arbitrary sequential number that is identified on one of seven maps of the White River, Utah (Figures A-1 to A-7). Five sample records are coded but not identified on any maps because either a specific sample site was not provided in the report or the sample involved a longitudinal reach of river.

Crosby (1975a,b) sampled the river at eight sites in the fall of 1974 and late summer of 1975 but issued a formal report on only the first effort (1975a). Samples were collected at the same sites both years with one additional site in 1975. Lanigan and Berry sampled at 15 specific sites and in two reaches of the river in 1978-1979. The initial report (1979) was followed by a publication (1981). Miller et al. (1982) described 22 sites

sampled by the FWS in 1981. A total of 13 sample sites were associated with the ERI (1982) efforts in 1981. Cooperative efforts between Radant et al.(1983) and the FWS (Miller et al. 1982) reduced the number of sample sites directly attributed to Radant et al. (1983) to three. The distribution of fish sample sites for 5-mile reaches within the White River, Utah (Figure 1) reveals the variation in sampling intensity. From one to eight sites were sampled for fishes within each five-mile reach. A paucity of samples appears to occur between RM 35 and RM 50, in which only a total of six sites were sampled.

Fish Species Composition and Distribution

A total of 17 fish species have been reported from the White River in Utah (Table 1) by six investigative groups between 1974 and 1982. These represent the following six families and the respective number of species: Cyprinidae (8), Catostomidae (3), Ictaluridae (2), Centrarchidae (2), Cottidae (1) and Salmonidae (1). Hybrids between razorback and flannelmouth suckers have also been found, as well as intergrades of the Gila complex, e.g. humpback chub x roundtail chub. Mountain whitefish (Corregonidae) are numerous in the upstream reaches of the White River in Colorado as shown by Prewitt et al.(1978). Common and scientific names of all fishes are presented in Table 1, while only common names are used in the text.

The most abundant species in the White River in Utah was the red shiner, according to four (Crosby 1975a, Lanigan and Berry 1979, Miller et al. 1982, Radant et al. 1983) of the five studies conducted mostly in Utah

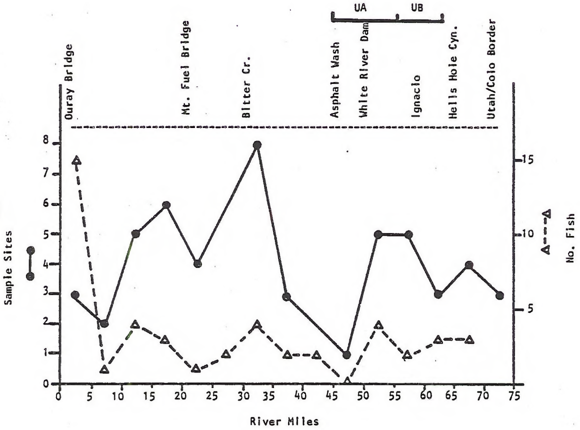

Figure 1. Number of fish sample sites and Colorado squawfish captured by 5-mile intervals in the White River, Utah 1974-1982, relative to Tracts UA and UB.

(Table 1). The species varied from 49.2 to 62.5 % of the catch. The ERI (1981) study found speckled dace (43%) were the most abundant followed by red shiner (32%). Generally, red shiner, speckled dace, flannelmouth suckers, roundtail chub and bluehead suckers were the most abundant fish species caught, together ranging in composition from 91.1 to 97.0%. Fathead minnows were the sixth most abundant fish species, followed by channel catfish and common carp. The remaining nine species occurred less frequently, including the endangered Colorado squawfish.

Of the 17 species reported in the White River, Utah, six were evolved in the river system and are classified as either native (also occur naturally in other river basins) or endemic (unique to the Colorado River basin). The remaining eleven species were introduced and are classified as nonnative (from other basins in North America) or exotic (from basins outside of North America). Appropriate designations are provided in Table 1.

Of the five most abundant species, only one (red shiner) was introduced. The other four (speckled dace, flannelmouth sucker, roundtail chub and bluehead sucker) are either native or endemic. The predominance of native or endemic fishes suggests that the White River has apparently not undergone significant habitat changes to enhance populations of introduced species at the expense of the native and endemic species.

The site-specific composition and longitudinal distribution of fishes in the White River is depicted in Figure 2. By using percentage of catch from selected fish sample sites of three investigative groups (Crosby 1975a,

Table 1. Fish species caught in the White River, Utah by percentage composition from 1974 to 1982.

Common Name (Scientific name)	Status[a]	Crosby 1975a[b] '74-'75	Prewitt et al. 1978[c] '77	Lanigan & Berry 1979[d] '78-79	Miller et al. 1982[e] '81	ERI 1982[e] '81	Radant et al. 1983[d] '82
Red shiner (*Notropis lutrensis*)	NN	51.8		62.5	49.2	32	57.7
Speckled dace (*Rhinichthys osculus*)	NA	27.8		8.3	20.5	43	15.8
Flannelmouth sucker (*Catostomus latipinnis*)	EN	10.8	71	8.6	13.8	13	11.4
Roundtail chub (*Gila robusta*)	NA	2.2	6	11.2	6.3	4	6.3
Bluehead sucker (*Catostomus discobolus*)	NA	4.2	8	<0.5	5.4	5	4.8
Fathead minnow (*Pimephales promelas*)	NN	2.6		5.5	2.6	1	2.8
Channel catfish (*Ictalurus punctatus*)	NN	2.4	1	0.6	0.1	1	0.2
Common Carp (*Cyprinus carpio*)	EX	0.8	2	2.6	1.4	<1	
Mountain whitefish (*Prosopium williamsoni*)	NA		11		0.4	<1	
Mottled sculpin (*cottus bairdi*)	NA		1			<1	
Colorado squawfish (*Ptychocheilus lucius*)	EN		1	<0.5	0.2		
Brown trout (*Salmo trutta*)	EX	<0.5		<0.5			
Green sunfish (*Lepomis cyanellus*)	NN			<0.5	0.1	<1	
Black bullhead (Ictalurus melas)	NN	<0.5		<0.5			
Smallmouth bass (*Micropterus dolomieui*)	NN	<0.5					
Gila cypha complex	--			<0.5			
Razorback x flannelmouth hybrid	--			<0.5			
White sucker (*Catostomus commersoni*)	NN					<1	
Sand shiner (*Notropis stramineus*)	NN					<1	
Redside shiner (*Richardsonius balteatus*)	NN					<1	

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a/ NA = native, EN = endemic, NN = nonnative, EX = exotic
b/ percentages from report total 102.6%
c/ all fishes collected in Colorado
d/ all fishes collected in Utah
e/ most fishes collected in Utah, some in Colorado

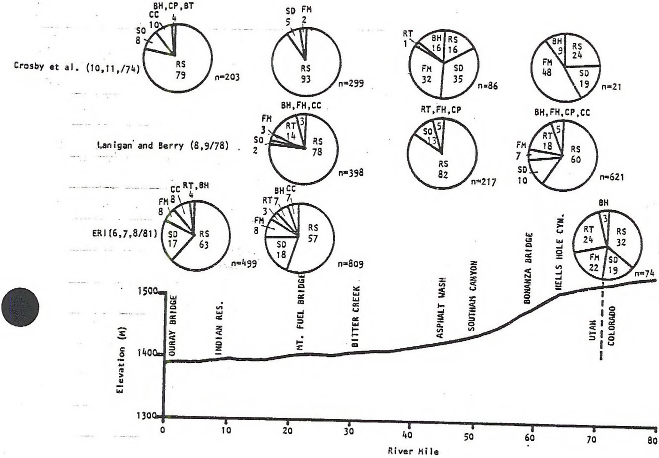

Figure 2. Composition of fishes in the White River, Utah by longitudinal distribution for the years 1974, 1978 and 1981.

Lanigan and Berry 1979, ERI 1982), longitudinal trends in species composition over time are perceptible.

The most apparent temporal and spatial trends are seen in the introduced red shiner. Crosby (1975a) found a predominance of red shiners (79-93%) in the lower 30 miles of river, with a shift to speckled dace (19-35%) and flannelmouth suckers (32-48%) from RM 30 to the Utah-Colorado border at about RM 70.

Lanigan and Berry (1979) found a similar predominance of red shiners but the pattern extended further upstream to Hell's Hole Canyon where the species made up 60% of the catch. Similarly, ERI found a predominance of red shiners near the confluence (63%) and at the Mt. Fuel Bridge (57%). A sample taken at the Utah-Colorado border in 1981 showed that red shiners still dominated the catch, but only with 32% composition. This pattern suggests that the red shiner has dominated the fish fauna of the lower White River since at least the early 70's. Its populations appear to vary yearly within sample sites. It is abundant in the downstream reaches and its numbers appear to be greatly diminished above the Utah-Colorado border as indicated by the studies in Colorado (Prewitt et al. 1978).

The second fish species exhibiting distributional trends is the native speckled dace. In no study cited did the speckled dace compose over 18% of the catch downstream of Asphalt Wash (RM 45). Upstream of this site, the speckled dace became more numerous and the red shiner less numerous. Catches further upstream in Colorado (ERI 1982) were dominated by speckled dace, although this is not reflected in Prewitt et al. (1978).

Flannelmouth suckers exhibit nearly the same longitudinal pattern as speckled dace. The species was uncommon in the downstream reaches but became more common in an upstream direction. Crosby (1975a) reported this species ranging in composition from 2% at the Mt. Fuel Bridge to 32% at Asphalt Wash and 48% at Hell's Hole Canyon. Lanigan and Berry (1979), however, reported that flannelmouths composed only 3% and 0% of the catch at the Mt. Fuel Bridge and Asphalt Wash, respectively. At Hell's Hole Canyon, flannelmouths made up only 7% of the catch. The ERI (1982) data also showed an upstream longitudinal increase in the species; 8% at both Ouray Bridge and Mt. Fuel Bridge and 22% at the Utah-Colorado border (RM 70).

No discernible longitudinal patterns were seen in the bluehead sucker and the roundtail chub. Crosby (1975a) found bluehead suckers more abundant (16%) in the Asphalt Wash area than in any other site, while Lanigan and Berry (1979) found them at low levels at the Mt. Fuel Bridge (3%) and at Hell's Hole Canyon (1%) but absent at Asphalt Wash. ERI (1982) studies revealed low numbers of bluehead suckers at Ouray Bridge, Mt. Fuel Bridge and the Utah-Colorado border (4, 7 and 3%, respectively).

The roundtail chub was found at only one site by Crosby (1975a), but Lanigan and Berry (1979) found the species common at the Mt. Fuel Bridge (14%) and at Hell's Hole Canyon (18%). ERI (1982) demonstrated a trend toward greater numbers of the species in an upstream direction from Ouray Bridge (2%) to Mt. Fuel Bridge (3%) to the Utah-Colorado border (24%).

Two trend modes are discernible in fishes of the White River, Utah; temporal trends and spatial or longitudinal trends. The temporal trends

occur over a period of 7 years (1974-1981) and across three investigative groups. Differences in gear type and sample variation confound any definitive trends in time, although the data suggest that the red shiner may be decreasing in numbers and the speckled dace increasing in the lower reaches. The Mt. Fuel Bridge station best illustrates this hypothesis; red shiners decreased from 93% of the catch in 1974 to 78% in 1978 to 57% in 1981. Conversely, speckled dace increased from 5 to 18% over the same period. These variations in abundance may also be attributed to year class strength and cohort size.

The spatial trends appear to be more defined than the temporal trends. As shown in ERI (1982), longitudinal trends in red shiners, speckled dace, flannelmouth suckers and roundtail chub appear to be a function of stream gradient and substrate. The lower 40 miles of the White River is dominated by a shifting silt/sand substrate that supports few macroinvertebrates for drift feeders like the speckled dace, flannelmouth suckers and roundtail chub. It does, however, provide backwater habitat for red shiners. The steeper gradient between RM 40 and RM 65 is associated with a gravel, cobble, boulder substrate that supports a more stable population of macroinvertebrates. This is reflected in greater numbers of the native and endemic species discussed above.

Although the data presented in Figure 2 were taken primarily in late summer and fall, variations in species composition are evident. These variations reflect natural biological phenomenon controlled largely by the physical nature of the White River. River discharge often controls

available habitat and temperature regimes which directly affect spawning success and year class strength. Discharge and temperature also affect longitudinal distribution of fishes, i.e. species move upstream or downstream to spawn or in response to cooling or warming temperatures.

Threatened and Endangered Fishes

Only two species of endangered fishes have been caught in the White River in Utah; these are the Colorado squawfish and the humpback chub. Colorado squawfish were first found in the White River, Utah by Lanigan and Berry (1979) in July 1978. A humpback chub was found in the White River, Utah in June 1981 and reported in Miller et al.(1982). Lanigan and Berry (1979) also reported a possible bonytail x humpback chub intergrade and a razorback x flannelmouth sucker hybrid in July 1978 and June 1979, respectively.

From July 1978 to September 1982, at least 83 Colorado squawfish have been caught in the White River, Utah (Table A-2). At least seven others have been sighted and not captured. All of the squawfish reported were either juveniles or adults, ranging in size from 267 to 711 mm total length and from 130 to 2830 g total weight.

The location of 46 known squawfish capture sites is presented in Figure 1 along with fish sample sites. Up to 15 squawfish have been captured in a 5-mile reach of river (RM 0-5). All other reaches have yielded one to four known captures. The distribution of these capture sites indicates that the endangered Colorado squawfish occurs periodically throughout the lower White

River at low numbers. The similar trends in fish sample sites and number of Colorado squawfish caught also suggests a relationship between effort and catch (Figure 1). Data from the 1983 field season are not available, but preliminary reports indicate additional squawfish were caught.

Tagging and radiotelemetry studies of the Colorado squawfish strongly suggest that the species moves freely between the White River and the Green River. Squawfish have been tracked from the Green River up the White River well into Colorado (Miller et al. 1982). There is, however, no evidence that the species spawns in the White River, i.e. no larvae or young-of-the-year have been recovered. The species does spawn in another nearby tributary of the Green -- the Yampa River.

DISCUSSION

All available fishery data of the White River in Utah from 1974 to 1982 have been assimilated into this analysis to assess the thoroughness of the data and its use in determining species composition and distribution. The first subsection of this discussion explores the feasibility of using fishes in the White River as a tool to monitor possible effects of the shale oil operation. The second subsection addresses the issue of endangered fishes in the White River and the potential impacts of the shale oil operation.

Fishes as a Monitoring Tool

The use of fishes as a long-term monitoring tool in riverine systems has only briefly been described in literature. Using fishes as a monitoring tool can be approached on one of two levels; (1) the individual level and (2) the population level. The individual level of monitoring can examine key species or "indicator" organisms in response to a perturbation. This concept has limited application, particularly with fishes, which generally possess wide tolerances to most impacts. It would have little utility in assessing subtle effects.

Another approach to the individual level of monitoring involves the physiological responses of individuals to a perturbation. Attempts to examine perturbation impacts on individuals have been made using behavioral locomotor responses (Kleerekoper 1975), respiration rates (Westlake and van der Schalie 1975), and even a measure of acetylcholinesterase activity on the central nervous system to detect sublethal effects of pesticides (Weber 1981). In all cases, fish were tested either in the laboratory or in cages held in the field. This is necessary with fishes because their mobility in riverine systems enables them to escape many lethal or sublethal effects. This is expected to be the case in the White River.

The population level of monitoring has received more attention and acceptance by fisheries biologists. Gaufin and Tarzwell (1956) showed that little reliance can be placed on mere occurrence of a single species in a given locality as an indicator of a perturbation. In evaluating the reliability of aquatic organisms as indicators of pollution, one must

consider different organisms not seperately but as biological associations or communities. The earliest thinking in this area was by theoretical ecologists who proposed using the concept of species diversity (Shannon and Weaver 1959, Pielou 1960, Wilhm 1970). The concept involves using an integrated mathematical approach to species composition and complexity that is sensitive enough to detect subtle changes in populations. The concept has been found valuable in detecting major impacts but has drawbacks in detecting subtle effects, especially in low-diversity ecosystems (Valdez 1973). The approach has received wide application and acceptance with macroinvertebrates (Gaufin 1973) but has had to be modified for use with fishes (Gammon et al. 1981).

One of the more logical and simple approaches to a monitoring problem was demonstrated by Marcy (1976) in evaluating the effects of the Connecticut Yankee Nuclear Power Plant on the lower Connecticut River. The area was monitored from 1965 to 1972 by using a "repeated, systematically-executed" collection scheme that involved sampling at only three specific sites with a predetermined effort using a standard set of gear types (seines and trawls). This scheme reduced the variability inherent in gear types and effort as well as that associated with habitat types. It allowed use of the percentage-composition statistic to assess differences in populations. By sampling a "control" station above the effluent, the percentage change attributed to natural variation was separated from the actual effect of the heated effluent. It should be noted, however, that this study assessed the impact of a point source

perturbation with substantial measurable effects.

From this discussion, it should be evident that an organism or group of organisms should possess the following four attributes to be useful as monitoring tools:

1. Populations should be relatively stable over time or vary in a predictable manner as a function of some measurable parameter.

2. Individuals should be largely sedentary to enable accumulation and manifestation of localized effects.

3. Individuals should be directly sensitive to anticipated impacts.

4. Individuals should have a short generation time to manifest maximum effects.

The fishes of the White River fail to possess any of these four attributes. Studies since 1974 show that the populations vary over time and in longitudinal distribution. Such variations might be ameliorated with a systematic sampling program of specific sites during the same season each month. Even such a repeated, systematically-executed program would likely be invalidated by the physical variation of the river. Annual fluctuations in discharge and temperature are likely to affect fish behavior and thus longitudinal distribution of species. Thus, variations in fish composition and densities at such a site may be a function of physical variables instead

of some induced perturbation. Also, annual variations in year class and cohort strength will further confound the analysis. Such variations in fish populations are controlled by many complex physical, chemical and biological variables.

Since fishes are at the top of the trophic pyramid in most stream ecosystems, the complexity of controlling variables is greatest. Fish have relatively long generation times when compared to periphyton (algae and diatoms), and they are highly and readily mobile. Thus, subtle impacts are often imperceptible in fishes at the population level because of normal population variation, and at the individual level because of the relatively slow growth and maturation, and long generation time.

Monitoring Fishes of the White River

The following discussion was developed in case a monitoring program of fishes would ever be needed on the White River to meet requirements for permitting. It is not intended as a proposal but rather to provide insight on the feasibility of such a program as well as an ecological perspective of the problems and the results and utility of such an effort.

It should first be recognized that the rivers of the upper Colorado River basin are largely controlled by extreme physical forces, i.e. discharge, temperature, sedimentation and scouring. These vary by several levels of magnitude annually, seasonally and even monthly, weekly or daily (as in the case of rain-induced floods or freshets). Thus, the biological parameters of these ecosystems are greatly variable. The White River

represents nearly the extreme of these physically-controlled ecosystems.

To establish a thorough monitoring program for fishes that could account for most natural variations and develop parameters sensitive enough to detect subtle impacts would be costly and time-consuming. It would involve frequent sampling with a variety of gear types in a labor-intensive fashion that would probably not yield results reliable enough to justify the efforts.

However, it is possible to monitor the fishes of the lower White River in such a manner as to develop indices of population composition and abundance that would reveal changes resulting from perturbations. The results of this approach may or may not serve to help monitor the White River ecosystem, especially in the case of subtle impacts. However, the approach should be sensitive enough to detect major changes in fish composition and distribution. It would also serve to monitor the occurrence of endangered fishes in the area.

The field sample effort would proceed as follows:

1. Select three sample sites, one above the anticipated impact area, one at the site and one below.

2. Sample a standard habitat type (riffles) with the same standard gear types in the same manner during each sample effort.

3. Sample during pre-runoff (April), mean flow (July) and base flow (Sept or Oct).

4. Analyze the percentage composition of each species for each catch effort.

5. Compare the statistic described in step 4 over time for the control site to assess "natural" changes and then subtract from the change seen between the "control" and the "affected" sites to assess perturbation effects.

This approach would reduce variability inherent in gear types, between habitats and for different flow conditions. It assumes that the river habitat at pre-runoff, mean and base flows would be similar between years. This in turn should reduce natural variations in populations due to behavioral locomotor responses. By sampling only at selected habitats at specific sites, variations in fish distribution are reduced. Since the most abundant fish species are red shiners, speckled dace, flannelmouth suckers, roundtail chub and bluehead suckers, the best habitat to sample would be riffles or backwaters. These are relatively easy to sample and they usually support a good complement of the most abundant species, especially the natives and endemics. These habitats also are preferred by the Colorado squawfish, and sampling them would enhance a monitoring program for threatened and endangered fishes.

The need to monitor fishes in the White River to assess the impacts of the WRSOC operation can be put into perspective in light of past findings and current needs. Past fisheries studies show the presence of certain fish species with wide variation in composition and distribution over time and space. These studies also reveal the presence of endangered fishes.

Although the relative effort of sampling fishes in the White River is lowest immediately downstream of Tract Ua, initiation of a fisheries program to monitor the WRSOC activities is inadvisable. The variation in past fisheries information suggests that only a time and labor-intensive effort would enable development of a data base sensitive enough to detect changes. This monitoring program would not be worth the investment since alternative partitions of the ecosystem are available for use as monitoring tools (e.g. periphyton, macroinvertebrates).

A reduced effort such as that just described is advised if a need arises to assimilate additional fisheries information. It is expected that such an effort would yield information as species composition and distribution similar to that of previous efforts, but it would not serve as a sensitive monitoring tool.

However, the presence of endangered species in the White River near Tracts Ua and Ub requires that WRSOC assimilate the best commercial and scientific information available to demonstrate that its operation will not adversely impact the survival of the species. The ongoing studies by the Fish and Wildlife Service and the Utah Division of Wildlife Resources are the best sources for this information, provided that their studies and

sample efforts are conducted adjacent to and downstream of Tracts Ua and Ub. If these two groups plan continued work on the White River, it should be feasible, through informal consultation with the appropriate FWS representative, to assess the need for additional fisheries work.

Current Studies and Data Gaps

On-going studies of the White River are part of the fisheries programs of the Fish and Wildlife Service, Utah Division of Wildlife Resources and Colorado Division of Wildlife. Efforts by these agencies are expected to vary annually, but it is expected that at least these three investigative groups will maintain a presence on the White River as long as permitting requests continue.

These agencies are expected to continue their emphasis on endangered fishes, particularly with radiotelemetry on Colorado squawfish. Fish abundance and distribution information will be continually gathered incidental to these endangered fish studies.

One critical data gap does exist with past and on-going studies of the White River. There are no known quantitative efforts to sample larval fish drift in this river. It is an element of the ecosystem that needs to be quantified if midchannel water intake structures are planned.

Fish larval drift needs to be assessed on the White River for two reasons:

1. To determine the potential for fish impingement and entrainment by the intake structure.

2. To assess the potential for impingement and entrainment of endangered fishes.

A drift study of larval fishes at proposed water intake structure sites is adviseable. Data from this study are essential in fully assessing potential impacts via impingement and entrainment for development of a Biological Assessment.

A larval fish drift study on the White River would involve drift nets placed at strategic locations under a systematic sample scheme from about early June to early September. It would involve an intensive field effort during this period followed by intensive laboratory analyses to sort and identify the larval fishes. This effort should not be costly but would yield information essential to a Biological Assessment.

LITERATURE CITED

Crosby, C. 1975a. White River fish collections. Utah Div. Wildlf. Resources, Regional Office, Vernal, Utah. Unpubl. mimeo. 10pp.

Crosby, C. 1975b. White River fish collections. Utah Div. Wildlf. Resources, Regional Office, Vernal, Utah. Field notes on memo to Earl Sparks. 2pp.

Ecosystem Research Institute. 1982. Impact Assessment of the White River Dam. Prepared for White River Shale Oil Corp. by E.R.I., Logan, Utah. Unpubl. report. 96pp.

Gammon, J.R., A. Spacie, J.L. Hamelink and R.L. Kaesler. 1981. Role of electrofishing in assessing environmental quality of the Wabash River. pp 307-324. IN: J.M. Bates and C.I. Weber (eds). Ecological Assessment of Effluent Impacts on Communities of Indigenous Aquatic Organisms. ASTM Special Tech. Publ. 730, 1916 Race St., Philadelphia, PA 19103.

Gaufin, A.R. and C.M. Tarzwell. 1952. Aquatic macroinvertebrate communities as indicators of organic pollution in Lytle Creek. Sewage Ind. Wastes. 28:906-925.

Gaufin, A.R. 1973. Use of aquatic invertebrates in the assessment of water quality. pp96-116. IN: J. Cairns, Jr. and K.L. Dickson (eds). Biological Methods for the Assessment of Water Quality. ASTM Special Publ. 528, 1916 Race St., Philadelphia, PA 19103.

Holden, P.B. and C.B. Stalnaker. 1975. Distribution and abundance of mainstream fishes of the middle and upper Colorado River Basins, 1967-1973. Trans. Amer. Fish. Soc. 104(2):217-231.

Kleerekoper, H. 1975. Some monitoring and analytical techniques for the study of locomotor responses of fish to environmental variables. pp110-120. IN: J. Cairns, Jr., K.L. Dickson and G.F. Westlake. Biological Monitoring and Water and Effluent Quality. Amer. Soc. for Testing and Materials Special Tech. Publ. 607. ASTM, 1916 Race St., Philadelphia, PA 19103.

Lanigan, S.H. and C.R. Berry, Jr. 1979. Distribution and abundance of endemic fishes in the White River in Utah. Final Contract Report for U.S. BLM by Utah Coop. Fish. Res. Unit, Utah State Univ. Unpubl. report. 84pp.

Lanigan, S.H. and C.R. Berry, Jr. 1981. Distribution of fishes in the White River, Utah. The Southwestern Naturalist. 26(4):389-393.

Marcy Jr., B.C. 1976. Fishes of the lower Connecticut River and the effects of the Connecticut Yankee Plant. pp61-113. IN: D. Merriman and L.M. Thorpe (eds.). The Connecticut River Ecological Study -- The Impact of a Nuclear Power Plant, Monograph No. 1 American Fisheries Society.

McAda, C.W. 1977. Aspects of the life history of three catostomids native to the upper Colorado River Basin. M.S. Thesis, Utah State Univ., Logan, Utah. 117pp.

McAda, C., C. Phillips, C.R. Berry, Jr. and R.S. Wydoski. 1977. A survey of endangered, threatened and unique fish in southeastern Utah streams within the coal planning area. Pages 1-265 IN: T.C. Boner, A.W. Heggen, C. McAda, C. Phillips, C.R. Berry, and R.S. Wydoski. A survey of endangered, threatened, and unique terrestrial and aquatic wildlife in Utah's coal planning area. Utah Dept. Natural Resources, Div. of Wildlf. Resources, Salt Lake City. 332pp.

Miller, W.H., D.L. Archer, H.M. Tyus, and K.C. Harper. 1982. White River Fishes Study. Final Report to U.S. BLM by Fish and Wildlife Service, Salt Lake City, Utah. Unpubl. report 58pp.

Pielou, E.C. 1960. A single mechanism to account for regular, random and aggregated populations. J. Ecology 48:575-584.

Prewitt, C.G., W.H. Wick, D.E. Snyder, and C.A. Carlson. 1978. Baseline survey of aquatic macroinvertebrates and fishes of the White and Yampa Rivers, Colorado. Semi-annual report. Dept. of Fishery and Wildlf. Biol., Colorado State Univ., Ft. Collins, CO. Unpubl. report. 29pp.

Radant, R.D., J.S. Cranney, R.G. Ruesink, and K. Rose. 1983. Colorado squawfish investigations, White River, Utah. Draft Final Report to U.S. BLM by Utah Div. Wildlf. Resources, Fish and Wildlf. Service. Unpubl. Report. 39pp.

Seethaler, K. 1978. Life history of the Colorado squawfish (Ptychocheilus lucius) in the Upper Colorado River Basin. M.S. Thesis. Utah State Univ., Logan, Utah. 156pp.

Shannon, C.E. 1948. A mathematical theory of communication. Bell System Techn. J. 27:379-423, 623-656.

Shannon, C.E. and W. Weaver. 1959. The mathematical theory of communication. Univ. of Illinois Press. pp7-63 and 95-117.

Valdez, R.A. 1975. Stability of stream communities exposed to underground nuclear tests on Anchitka Island, Alaska. Ph.D. Dissertation, Utah

State Univ. Logan. 117pp.

Weber, C.I. 1981. Evaluation of the effects of effluents on aquatic life in receiving waters--an overview. pp3-13. IN: J.M. Bates and C.I. Weber (eds). Ecological Assessments of Effluent Impacts on Communities of Indiginous Aquatic Organisms. ASTM Special Tech. Publ. 730, 1916 Race St., Philadelphia, PA 19103.

Westlake, G.F. and W.H. van der Schalie. 1975. Evaluation of an automated biological monitoring system at an industrial site. pp30-37. IN: J. Cairns, Jr., K.L. Dickson, and G.F. Westlake. Biological Monitoring and Water and Effluent Quality. Amer. Soc. for Testing and Materials Special Tech. Publ. 607. ASTM, 1961 Race St., Philadelphia, PA 19103.

Wilhm, J.L. 1970. Range of diversity index in benthic macroinvertebrate populations. J. Water Poll. Control Fed. 42, R221:219-221.

Vanicek, C.D. 1967. Ecological studies of native Green River fishes below Flaming Gorge Dam, 1964-1966. Doctorate Dissertation, Utah State Univ., Logan, Utah. 124pp.

Vanicek, C.D., R.H. Kramer and D.R. Franklin. 1970. Distribution of Green River fishes in Utah and Colorado following closure of Flaming Gorge Dam. Southwest Nat. 14(3):297-315.

APPENDIX A

Table A-1. Location and description of known fish sample sites on the White River in Utah, January 1984.

Sample Code	Map No.	Investigators	Dates Sampled	Site-River Miles Sampled[a/]	Sample Type
CR01	2	Crosby 1975a	10/15/74	Hell's Hole Canyon-64.0	electrofishing hoop net,minnow trap,100' seine[b/]
		Crosby 1975b	9/10/75	Hell's Hole Canyon-64.0	electrofishing hoop net,minnow trap,100' seine
CR02	2	Crosby 1975a	10/16/74	Bonanza(Ignacio)Bridge-59.4	electrofishing, 100' seine
		Crosby 1975b	9/10/75	Bonanza(Ignacio)Bridge-59.4	electrofishing, 100' seine
CR03	2	Crosby 1975a	10/17/74	Southam Canyon-50.0	electrofishing, 100' seine
		Crosby 1975b	9/10/75	Southam Canyon-50.0	electrofishing, 100' seine
CR04	3	Crosby 1975a	10/17/74	Asphalt Ridge-45.0	electrofishing, 100' seine
		Crosby 1975b	9/10/75	Asphalt Ridge-45.0	electrofishing, 100' seine
CR05	4	Crosby 1975a	11/20/74	Bitter Creek-31.2	electrofishing, 100' seine
		Crosby 1975b	9/9/75	Bitter Creek-31.2	electrofishing, 100' seine
CR06	5	Crosby 1975a	11/20/74	Mt. Fuel Bridge-21.7	125'x6' mono gill net,electrofishing,100' seine
		Crosby 1975b	9/9/75	Mt. Fuel Bridge-21.7	125'x6' mono gill net,electrofishing,100' seine
CR07	5	Crosby 1975a	11/21/74	Indian Reservoir-19.1	electrofishing, 100' seine
		Crosby 1976b	9/9/75	Indian Reservoir-19.1	electrofishing, 100' seine
CR08	7	Crosby 1975a	11/22/74	Ouray Bridge-0.3	electrofishing, 100' seine
		Crosby 1975b	9/9/75	Ouray Bridge-0.3	electrofishing, 100' seine
CR09		Crosby 1975b	9/9/75	Between Mt.Fuel Bridge(21.7) and Ouray(0.3)	unknown
MC01		McAda et al. 1977	9/14-9/16/76	1.8 - 3.0	unknown
B01	1	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Little Dick's Bottom-69.9	electrofishing, seines, trammel nets, frame nets, experimental gill net
LB02	1	Lanigan&Berry 1979,1981	4/30-5/3/79 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Cowboy Canyon-67.0	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB03	2	Lanigan&Berry 1979,1981	7/30-8/2/79 8/21-8/24/78 9/11-9/14/78	Hell's Hole Canyon-63.3	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB04	2	Lanigan&Berry 1979,1981	7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Ignatio upstream-60.2	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB05	2	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Ignatio - 59.4	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB06	2	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Walkable Wash-56.5	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB07	2	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Old Cabin Site-56.0	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB08	2	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	VTN - 52.5	electrofishing,seines,trammel nets,frame nets, experimental gill nets

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[a/] approximate river miles; a discrepancy was found in river miles as designated by FWS and Lanigan & Berry (1979)

[b/] Crosby (1975) also used primer cord and ditching powder explosives at two unidentified sites.

Table A-1. (Continued).

Sample Code	Map No.	Investigators	Date Sampled	Site-River Miles Sampled$^{a/}$	Sample Type
LB09	2	Lanigan&Berry 1979,1981	4/30-5/3/79 7/30-8/2/78 8/21-8/29/78 9/11-9/14/78	Dam Site - 50.6	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB10	3	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Asphalt Wash - 43.8	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB11	3	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Atches Wash - 39.5	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB12	4	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Bitter Creek - 31.2	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB13	4	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78	White Site - 29.8	electrofishing,seines,trammel nets,frame nets, experimental gill nets
B14	5	Lanigan&Berry 1979,1981	4/30-5/3/79 7/21-7/25/78 7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Site 20 - 23.5	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB15	5	Lanigan&Berry 1979,1981	7/30-8/2/78 8/21-8/24/78 9/11-9/14/78	Mt. Fuel Bridge - 22.3	electrofishing,seines,trammel nets,frame nets, experimental gill nets
LB16		Lanigan&Berry 1979,1981	7/8-7/11/78 9/26-9/28/78	Mt. Fuel Bridge(22.3) to Green River Confluence(0.0)	AC electrofishing boat
LB17		Lanigan&Berry 1979,1981	5/29-5/31/79 6/11-6/14/79	Cowboy Canyon(67.0) to Mt.Fuel Bridge (21.3)	DC electrofishing boat
ML01	7	Miller et al. 1982	6/24-6/27/81	1.0	electrofishing,seines,trammel nets,gill nets
ML02	6	Miller et al. 1982	6/24-6/27/81	6.0	electrofishing,seines,trammel nets,gill nets
ML03	6	Miller et al. 1982	10/13-10/16/81	10.0	electrofishing,seines,trammel nets,gill nets
ML04	6	Miller et al. 1982	10/13-10/16/81	15.0	electrofishing,seines,trammel nets,gill nets
ML05	6	Miller et al. 1982	5/20-5/21/81	11.0	electrofishing,seines,trammel nets,gill nets
ML06	6	Miller et al. 1982	5/20-5/21/81	16.0	electrofishing,seines,trammel nets,gill nets
ML07	6	Miller et al. 1982	8/12-8/13/81	12.5	electrofishing,seines,trammel nets,gill nets
ML08	5	Miller et al. 1982	8/12-8/13/81	19.1	electrofishing,seines,trammel nets,gill nets
ML09	6	Miller et al. 1982	4/15-4/16/81	13.0	electrofishing,seines,trammel nets,gill nets
ML10	5	Miller et al. 1982	4/15-4/16/81	18.5	electrofishing,seines,trammel nets,gill nets
ML11	5	Miller et al. 1982	8/10-8/12/81	25.2	electrofishing,seines,trammel nets,gill nets
ML12	4	Miller et al. 1982	8/10-8/12/81	31.0	electrofishing,seines,trammel nets,gill nets
3	5	Miller et al. 1982	6/23-6/24/81	28.0	electrofishing,seines,trammel nets,gill nets
ML14	4	Miller et al. 1982	6/23-6/24/81	33.0	electrofishing,seines,trammel nets,gill nets
ML15	4	Miller et al. 1982	5/19-5/20/81	34.0	electrofishing,seines,trammel nets,gill nets
ML16	3	Miller et al. 1982	5/19-5/20/81	39.0	electrofishing,seines,trammel nets,gill nets

Table A-1. (Continued).

Sample Code	Map No.	Investigator	Dates Sampled	Site-River Miles Sampled[a]	Sample Type
ML17	3	Miller et al. 1982	10/20-10/22/81	39.6	electrofishing,seines,trammel nets,gill nets
ML18	3	Miller et al. 1982	10/20-10/22/81	44.9	electrofishing,seines,trammel nets,gill nets
ML19	2	Miller et al. 1982	4/13-4/14/81	54.0	electrofishing,seines,trammel nets,gill nets
ML20	2	Miller et al. 1982	4/13-4/14/81	59.0	electrofishing,seines,trammel nets,gill nets
ML21	1	Miller et al. 1982	6/2-6/4/81	66.0	electrofishing,seines,trammel nets,gill nets
ML22	1	Miller et al. 1982	6/2-6/4/81	71.0	electrofishing,seines,trammel nets,gill nets
ER01	7	Ecosystem Res. Inst.1982	6/26/81	0.4	seines
ER02	6	Ecosystem Res. Inst.1982	6/24/81	5.6	seines
ER03	6	Ecosystem Res. Inst.1982	8/14/81	12.5	seines
ER04	5	Ecosystem Res. Inst.1982	8/12/81	19.1	seines
ER05	5	Ecosystem Res. Inst.1982	8/12/81	25.2	seines
R06	5	Ecosystem Res. Inst.1982	6/24/81	27.6	seines
R07	5	Ecosystem Res. Inst.1982	6/24/81	27.7	seines
ER08	4	Ecosystem Res. Inst.1982	8/11/81	31.0	seines
ER09	4	Ecosystem Res. Inst.1982	6/23/81	32.8	seines
ER10	4	Ecosystem Res. Inst.1982	5/20/81	34.0	seines
ER11	1	Ecosystem Res. Inst.1982	7/30/81	70.8	seines
ER12	1	Ecosystem Res. Inst.1982	7/30/81	71.0	seines
ER13	1	Ecosystem Res. Inst.1982	7/30/81	71.6	seines
RA01[c]	2	Radant et al. 1983	7/19-8/1/82	50.6	drift nets for larval fish
RA02	5	Radant et al. 1983	7/19-8/1/82	22.9	drift nets for larval fish
RA03		Radant et al. 1983	5/25-7/2/82	0-72	electrofishing,seines,trammel nets,gill nets

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c/ specific sample site locations not given in report.

Table A-2. Location and description of known captures of threatened or endangered fishes in the White River in Utah, January 1984.

Map Code	Map No.	Investigators	Date Captured or Located	Site-River Mile	Fish Species	Total Length (mm)	Weight (g)	Tag or I.D.
CS01	7	Lanigan&Berry 1979,1981	7/11/78	0.6	Colorado squawfish	482	850	USUBM100210
CS02	7	Lanigan&Berry 1979,1981	7/11/78	0.0	Colorado squawfish	519	1240	USUBM100209
CS03	7	Lanigan&Berry 1979,1981	7/11/78	0.7	Colorado squawfish	595	1000	USUBM100208
CS04	7	Lanigan&Berry 1979,1981	9/28/78	0.6	Colorado squawfish	620	1950	USU0991
CS05	7	Lanigan&Berry 1979,1981	9/28/78	0.5	Colorado squawfish	444	590	USU0987
CS06	6	Lanigan&Berry 1979,1981	9/28/78	6.3	Colorado squawfish	526	1066	USU0992
CS07	4	Lanigan&Berry 1979,1981	6/14/79	29.8	Colorado squawfish	478	800	USUBM100206
CS08	3	Lanigan&Berry 1979,1981	5/29/79	42.3	Colorado squawfish	525	1180	USUBM100207
CS00[a]	6-7	Lanigan&Berry 1979,1981	1978-1979	0.1,0.2,0.2,0.3,0.3 1.5,11.8	Colorado squawfish	--	--	--
CH01		Lanigan&Berry 1979,1981	7/11/78	0.0-21.3[b]	bonytail x humpback chub hybrid	345	--	--
RF01	2	Lanigan&Berry 1979,1981	6/12/79	51.8	razorback x flannelmouth sucker hybrid	465	125[c]	--
CS09	4	Miller et al. 1982	8/12/81	31	Colorado squawfish	557	--	RT[d] 1538
CS10	5	Miller, et al. 1982	8/21/81	18	Colorado squawfish	552	--	RT 1559
CS11	2	Miller et al. 1982	4/15/81	54	Colorado squawfish	450	--	RT 1601
CS12	2	Miller et al. 1982	4/15/81	54	Colorado squawfish	470	760	RT 1603
CS13	5	Miller et al. 1982	8/21/81	19	Colorado squawfish	626	--	RT 1608
CS14	1	Miller et al. 1982	5/29/81	68	Colorado squawfish	550	--	RT 1624
CS15	7	Miller et al. 1982	6/26/81	1.7	Colorado squawfish	471	675	CT[e] 0259
CS16-CS45[b]		Miller et al. 1982	4/15-4/16/81 5/20-5/21/81 6/24-6/27/81 8/12-8/13/81 10/13-10/16/81	18.5-13.0 16.0-11.0 6.0-1.0 19.1-12.5 15.0-10.0	Colorado squawfish	--	--	--
CS46-CS53[b]		Miller et al. 1982	4/13-4/14/81 5/19-5/20/81 6/23-6/24/81 8/10-8/12/81 10/20-10/22/81	59.0-54.0 39.0-34.0 33.0-28.0 31.0-25.2 44.9-39.6	Colorado squawfish	--	--	--
CS54-CS60[b]		Miller et al. 1982	6/2-6/4/81	71.0-66.0	Colorado squawfish	--	--	--
CH02[b]		Miller et al. 1982	--	--	humpback chub	--	--	--
CS61[f]	6	Radant et al. 1983	5/26-6/29/82	12.5-0.8	Colorado squawfish	453	666	RT3024
CS62[f]	2	Radant et al. 1983	6/11-11/24/82	50.0-Gr River	Colorado squawfish	576	1560	RT3036
CS63[f]	2	Radant et al. 1983	6/11-7/2/82	59.1-10.4	Colorado squawfish	550	1150	RT3060
CS64[f]	1	Radant et al. 1983	6/17-7/6/82	68.9-48.2	Colorado squawfish	592	1480	RT3026

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a/ fish observed but not captured
b/ specific capture location not given in report
c/ probably erroneous weight-a ripe, tuberculate male
d/ RT = radiotag
e/ CT = carlin tag
f/ radiotagged fish observed over dates and river miles shown, first mile is capture location

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A SURVEY OF FISH COLLECTIONS
IN THE WHITE RIVER, UTAH

ERI (W012 - 01)

Prepared For: White River Shale Oil Corporation

Prepared By: Richard A. Valdez, Ph.D.
Ecosystem Research Institute
975 South State Highway
Logan, Utah 84321
(801) 752-2580

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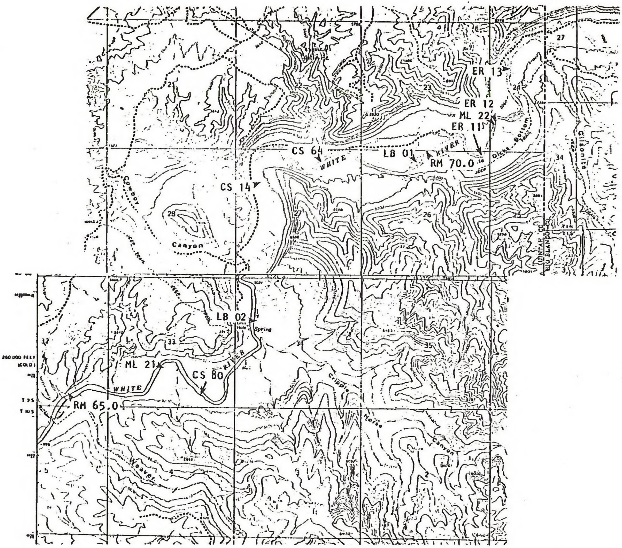
January 1984

Table A-2. (Continued).

Map Code	Map No.	Investigators	Date Captured or Located	Site-River Mile	Fish Species	Total Length (mm)	Weight (g)	Tag or I.D.
CS65[f/]	2	Radant et al. 1983	6/17-11/24/82	64.3-Gr. River	Colorado squawfish	694	2830	RT3051
CS66[f/]	4	Radant et al. 1983	6/23-9/20/82	33.2-Gr. River	Colorado squawfish	711	2740	RT3093
CS67[f/]	5	Radant et al. 1983	6/24-9/2/82	17.2-Green-Yampa	Colorado squawfish	645	2670	RT3057
CS68[f/]	6	Radant et al. 1983	7/1-7/2/82	14.8-14.7	Colorado squawfish	540	1080	RT3075
CS69	5	Radant et al. 1983	6/3/82	20.8	Colorado squawfish	411	470	--
CS70	2	Radant et al. 1983	6/4/82	58.6	Colorado squawfish	332	240	--
CS71	2	Radant et al. 1983	6/7/82	63.1	Colorado squawfish	273	130	--
CS72	2	Radant et al. 1983	6/16/82	64.9	Colorado squawfish	483	850	--
CS73	4	Radant et al. 1983	6/22/82	32.1	Colorado squawfish	364	375	--
CS74	4	Radant et al. 1983	6/23/82	29.5	Colorado squawfish	485	820	--
CS75	6	Radant et al. 1983	7/1/82	14.8	Colorado squawfish	378	390	--
CS76	3	Radant et al. 1983	7/14/82	38.8	Colorado squawfish	267	130	--
CS77	3	Radant et al. 1983	7/22/82	37.2	Colorado squawfish	390	380	--
S78	3	Radant et al. 1983	7/22/82	42.2	Colorado squawfish	480	920	--
CS79	4	Radant et al. 1983	9/8/82	34.1	Colorado squawfish	364	300	--
CS80	1	Radant et al. 1983	9/14/82	66.3	Colorado squawfish	540	1150	--
CS81	7	McAda et al. 1978	9/14-9/16/78	1.8-3.0	Colorado squawfish	--	--	--
CS82	7	McAda et al. 1978	9/14-9/16/78	1.8-3.0	Colorado squawfish	--	--	--
CS83	7	McAda et al. 1978	9/14-9/16/78	1.8-3.0	Colorado squawfish	--	--	--

p 1


ER 13
ER 12
ML 22
ER 11
CS 64
WHITE
LB 01
RIVER
RM 70.0
Dicks Bottom
Gilsonite
CS 14
Cowboy
Canyon
UINTAH CO
RIO BLANCO CO
LB 02
Spring
ML 21
CS 80
WHITE
RIVER
RM 65.0
Cripple
Horse
Canyon
Weaver
260 000 FEET (COLO)
T 9 S
T 10 S
27
22
23
24
34
28
27
26
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3
2

Figure A-1. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

Map 2

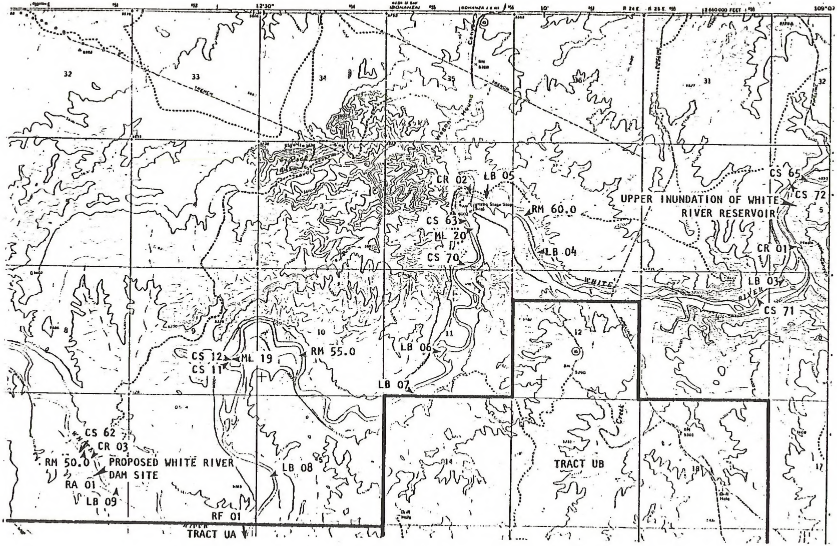
CR 02
LB 05
CS 65
CS 72
UPPER INUNDATION OF WHITE RIVER RESERVOIR
RM 60.0
CS 63
ML 20
CS 70
LB 04
CR 01
LB 03
WHITE RIVER
CS 71
CS 12
ML 19
CS 11
RM 55.0
LB 06
LB 07
CS 62
CR 03
RM 50.0
PROPOSED WHITE RIVER DAM SITE
RA 01
LB 09
LB 08
RF 01
TRACT UA
TRACT UB
32
33
34
35
36
31
32
5
3
8
9
10
11
12
14
17
18
Creek

Figure A-2. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

p 3

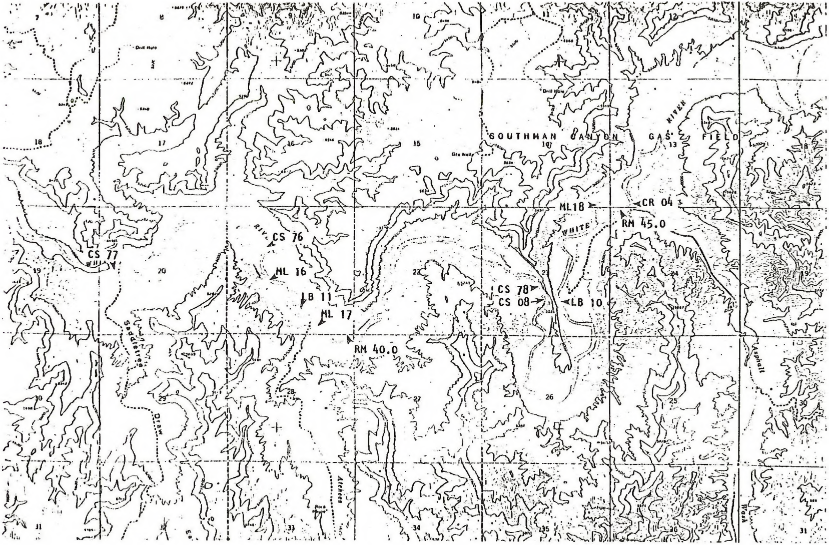
SOUTHMAN CANYON GAS FIELD
RIVER
WHITE
RIV.
CS 76
CS 77
ML 16
LB 11
ML 17
RM 40.0
ML18
CR 04
RM 45.0
CS 78
CS 08
LB 10
Saddletree
Draw
Asphalt
Wash
Drill Hole
Gas Well
7
8
9
10
11
12
18
17
16
15
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Figure A-3. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

ap 4

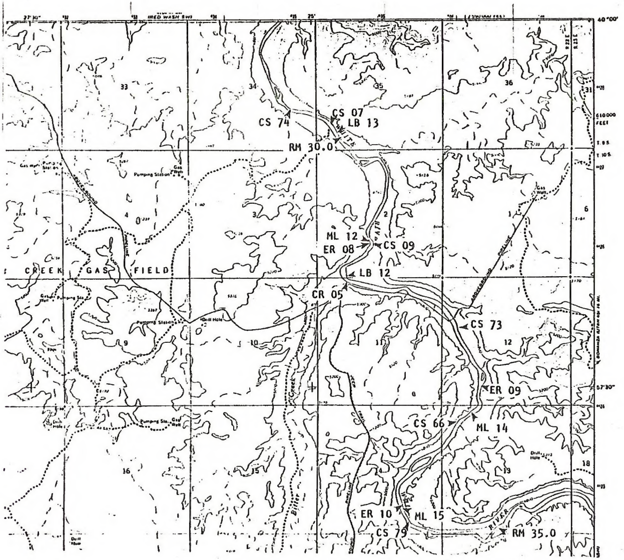
CS 74
CS 07
LB 13
RM 30.0
WHITE
ML 12
ER 08
CS 09
RIVER
CREEK GAS FIELD
LB 12
CR 05
CS 73
ER 09
CS 66
ML 14
ER 10
ML 15
CS 79
RIVER
RM 35.0
Pumping Station
Gas Well
Drill Hole
Bitter Creek
33
34
35
36
31
4
3
2
1
6
9
10
11
12
16
15
13
18
40°00'
57'30"
25'
27'30"
T. 9 S.
T. 10 S.
R 22 E
R 23 E

Figure A-4. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

p 5

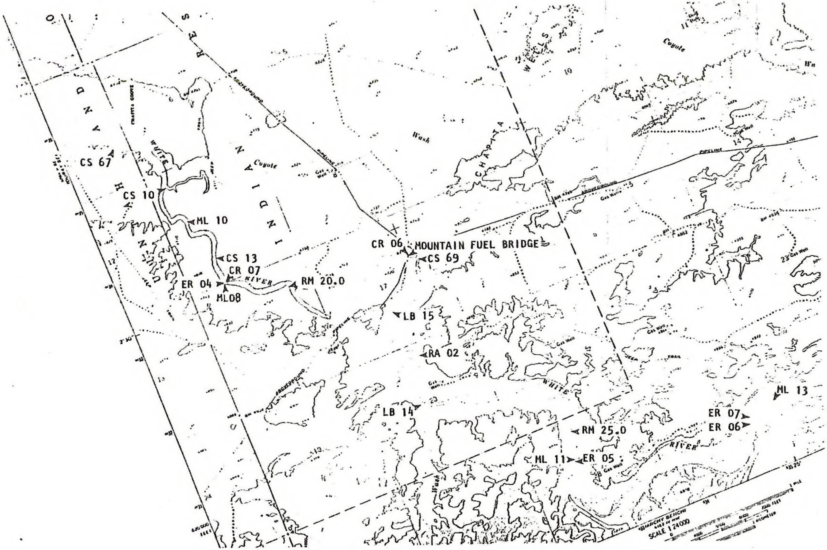
CS 67
CS 10
ML 10
CS 13
CR 07
ER 04
ML08
RIVER
RM 20.0
CR 06
MOUNTAIN FUEL BRIDGE
CS 69
LB 15
RA 02
LB 14
RM 25.0
ML 11
ER 05
ER 07
ER 06
ML 13
WHITE
RIVER
Coyote
Wash
CHAPITA WELLS
UINTAH AND OURAY INDIAN RES
PIPELINE
SCALE 1:24000

Figure A-5. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

Map 6

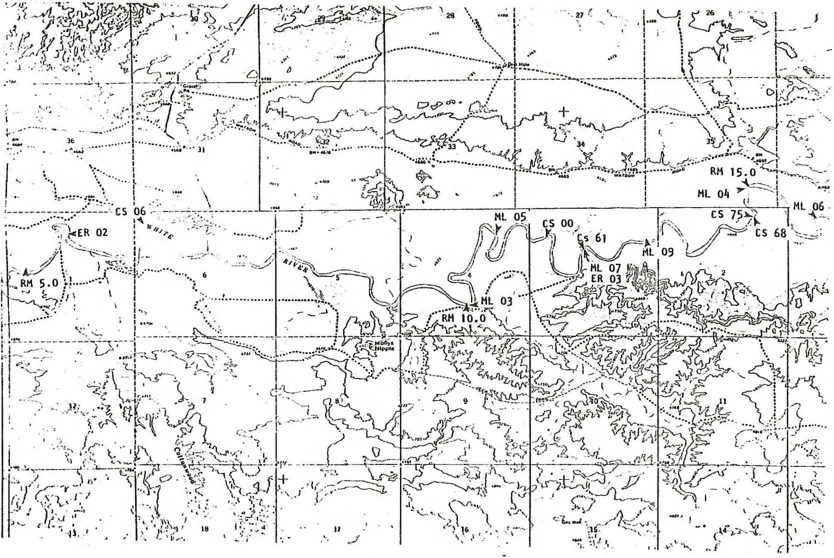
CS 06
ER 02
WHITE
RIVER
RM 5.0
RM 15.0
ML 04
ML 06
CS 75
CS 68
ML 05
CS 00
Cs 61
ML 09
ML 07
ER 03
ML 03
RM 10.0
Mollys Nipple
Cottonwood
WATSON
ROAD
Dry Hole
Gas Well

Figure A-6. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

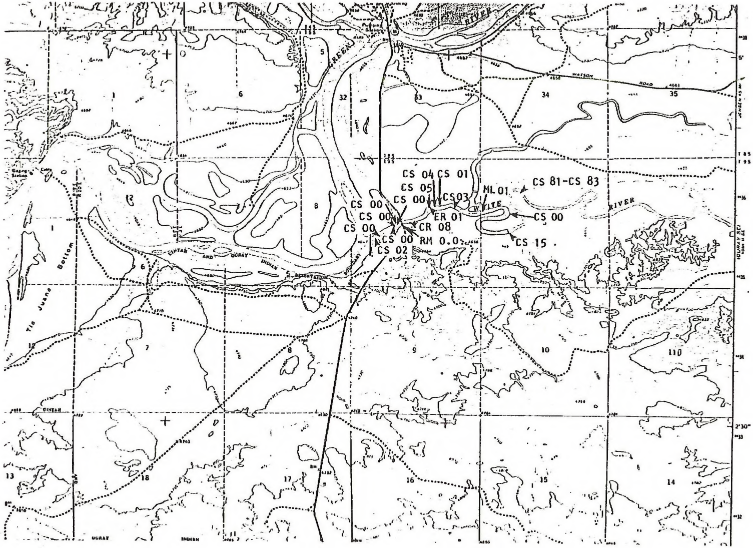
GREEN
RIVER
WATSON ROAD
WHITE
RIVER
CS 04
CS 01
CS 05
CS 00
CS 03
ML 01
CS 81-CS 83
CS 00
CS 00
ER 01
CS 00
CS 00
CR 08
CS 00
RM 0.0
CS 02
CS 15
UINTAH AND OURAY INDIAN RESERVATION
BOUNDARY
Tio Juana Bottom
T 8 S
T 9 S
1
5
6
32
33
34
35
12
1
8
7
9
10
11
13
18
17
16
15
14
2°30"

Figure A-7. Location of fish sample sites and captures of Colorado squawfish in the White River, Utah from 1974 to 1982.

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